6. RESULTS AND CONCLUSIONS

6.1 Explanation of Flow Paths

The RU entered PORTS from two sources. The first source was the stream derived from spent reactor fuel that had been converted to UF_6 at the PGDP and ORGDP feed manufacturing facilities. A total of 1,094.6 MTU was fed to the cascade (~0.64 assay). The second source was materials received in various chemical forms through the scrap returns program (see Table 5.1-2).

The constituent ^{99}Tc reached PORTS through the RU and PPF. Since startup, some 58 kg of ^{99}Tc are estimated to have entered the PORTS cascade from PPF and 6 kg from RU for a total of 64 kg fed to the cascade. Some previous estimates have placed this level as high as 90 kg.

6.2 Identification and Evaluation of Processes or Facilities That Involved Worker Exposure to Recycled Uranium Constituents

There are no known documented cases of worker exposure to TRU constituents of RU at PORTS from any process. There have been cases of worker contamination due to ^{99}Tc. Exposures to ^{99}Tc through ingestion are TBD. There was the potential for worker exposure in the following facilities/work areas:

1. Oxide Conversion Facility;

2. cascade during removal of cascade equipment;

3. equipment decontamination in X-705 equipment; and

4. cylinders cleaning.

In-vivo results from workers are available since 1965. The HP staff was concerned about exposures to insoluble Np compounds during CIP/CUP. Urine bioassay results are available from 1955 and indicate that uranium and ^{99}Tc exposures have occurred. It is not yet known whether these exposures indicated by urine bioassay also include a contribution from TRU.

Dose assessments for workers with positive bioassay have been required and performed since 1988. No worker has been assigned an internal dose from ^{99}Tc or TRU since that time. Air and smear samples taken since 1993 to characterize the radioactive constituents in the facilities listed above also indicate that TRU is present, but may not be significant.

6.3 Identification and Evaluation of Processes or Facilities that Involved Potential Environmental Contamination

The only record of environmental releases of TRU constituents occurred between October 1976 and March 1977 when one sample above the minimum detection limit (MDL) was detected in the outfall from the X-701B. There are extensive records and cases of environmental contamination due to ^{99}Tc. The section above lists the facilities / work areas into which RU was introduced. Technetium has been found in site disposal areas where contaminated equipment was stored, oil and cleaning solvents were disposed of, and in air (stack and perimeter) and water effluent monitors. Perimeter air sampling generally indicates only naturally occurring materials, but ^{99}Tc was found after the 1998 fire in X-326. Groundwater sampling has indicated that technetium is present in plumes originating from the X-701B Holding Pond. Technetium has higher mobility than uranium and the other RU constituents.

The immediate area around the X-705 has contamination on pavement and in soil. Because the source was the X-705, ^{99}Tc and TRU are expected to be present. The X-705A Incinerator Facility was operated until 1986 to dispose of burnable waste. Contamination measurements made of the interior surfaces during demolition indicated that ^{99}Tc and TRU were present. Contamination surveys in the vicinity of these facilities have located small areas of surface soil contamination. These areas have been posted to protect workers from exposure, but have not been extensively characterized to determine if they contain ^{99}Tc or other constituents of RU.

6.4 Discussion of Data Sources and Confidence Levels

Information utilized in this report was gathered from various sources. Factors influencing the quality of the information vary from the level of documentation in which the information was found to the credibility of the individual supplying the data. Certain types of data clearly have, as their bases, physical and chemical measurements supported by reliable documentation including chain of custody records, weight tickets, and lab instrument printouts. At the other extreme, anecdotal testimony of "how things were done" may be highly dependent on fading memories or hearsay information. In some cases, conclusions could be arrived at only through deductive reasoning and, in a few cases, speculation. Table 6.4-1 lists the sources and/or types of sources utilized, with the team's assessment of the reliability of the information based on their collective experience.

Where deductive reasoning and/or educated speculation were critical in coming to closure with an issue in this report, such steps in logic are cited. In these cases, the 185 years of collective experience of the site team has been relied upon.

6.5 Conclusions

In reviewing the operating history of PORTS (including facilities and specific time periods), where there are significant implications for potential worker exposure or environmental contamination certain conclusions can be made with reasonable confidence. These are as follows:

1. The largest quantity of recycled uranium received and fed to the PORTS cascade was manufactured at PGDP and ORGDP from recycled UO_3 from Hanford and Savannah River. Of the approximately 320,817 MTU fed to the PORTS cascade through FY 1997, 1,095 MTU was RU processed at the PGDP or ORGDP feed plants.

2. The largest contribution of ^{99}Tc, which amounted to about 60 to 90 kg, was in the 121,485 MTU of feed produced by PGDP.

3. Facilities and associated processes where TRU constituents had the most potential for worker exposure were in the cascade near the RU feed points, particularly during equipment removal, and the Oxide Conversion Facility when changing the ash filters.

4. Possible exposure to ^{99}Tc could have occurred during maintenance of the top purge cells or change-out of trapping media near these locations. Potential exposure to ^{99}Tc from the handling of treatment sludges from the uranium recovery facility is considered unlikely due to the dilution of this stream with enormous quantities of non-radiological materials.

5. The X-344 Feed Manufacturing Facility was free of TRU/FP constituents during its operating history.

The site team lists opportunities for improvement to the PORTS RU mass balance effort in Table 6.5-1. The recommended actions are listed in order of priority for clarifying worker exposure or environmental contamination.

Table 6.4-1

Data Sources and Assessment of Data Quality – PORTS Site

Item	Data Source	Quality of Information			Comments
		High	Med.	Low	
1	SS Accountability Records	X			
2	Plant Monthly Inventory Reports	X			
3	NMMSS Data Base Queries		X		Dependent on setting of proper filters
4	NMC&A-DEC10 Journals (VHE-refeed)	X			
5	Supplemental Analysis Reports (Scrap) GAT-XXX-XX-XX		X		
6	Nuclear Materials Transaction Reports Typically DOE/NRC-741	X			
7	HEU Refeed Program Cylinder Cleaning and Shipment Schedules	X			Historical
8	Operational Log Books	X			
9	Oxide Conversion Feed Sheets		X		Were followed on a best effort basis only
10	Plant and Department Activity Reports		X		Evolving format and content
11	Plant Interdepartmental Correspondence		X		Citations and references at times are lacking
12	GAT.POEF OR and Paducah Formal Plant & Technical Reports	X			
13	Interviews with Plant Current and Former Employees			X	Unsubstantiated and opinionated
14	Consonant Interviews with Multiple Current and Former Employees		X		Subject to “group think”
15	Dissonant interviews with Multiple Current and Former Employees			X	
16	Personnel Notes, Memos to File		X		
17	Correspondence Between AEC/ERDA/DOE Site Operations Office and Operating Contractors	X			
18	Drawings/Photographs of Systems and Facilities	X			
19	Operating and Maintenance Procedures		X		Implemented on a graded approach

Table 6.5-1

Opportunities for Improvement - Prioritized

Priority	Improvement	Remarks
1	Evaluate potential for worker exposure and/or environmental contamination from 1998 X-326 side purge fire	Clean-up/repair work currently progressing; high potential for ^{99}Tc and Np contamination; documentation may be readily available.
2	Evaluate X-744G facilities/activities for potential worker exposure	Large quantities of oxide, solutions, nitrate, and trapping materials containing possible TRU/FP were sampled or batched over the operating history.
3	Evaluate X-710 facilities/activities for potential worker exposure	Handled small quantities of TRU/FP under experimental conditions
4	Quantify flow paths for recycled waste streams (i.e., ion exchange resins, heavy metals sludge, etc.) from uranium recovery facility	Streams are probably low in TRU content, but high in ^{99}Tc
5	Evaluate flow path of 17 MTU enriched (15.5 MTU with assay of 0.7103 and 1.5 MTU with assay of 0.85303) UF_6 received from ORGDP in FY 1961	Categorized as non-TRU, but lack certainty
6	Quantify flow paths for various trapping materials (i.e., alumina, NaF, and MgF_2)	High potential for worker exposure, but effort may be time consuming
7	Evaluate X-760 facilities/processes/activities (i.e., Fluorox process, etc.) for potential worker exposure (particularly in late 1950's and early 1960's)	Quantities of depleted RU (i.e., about 0.4 MTU UO_2, 3.3 MTU UO_3, and 0.9 MTU UF_4) received from ORGDP in FY 1957 may have been used for early plant reactor studies in X-760, but records could not be retrieved in time for this report
8	Quantify flow path for ^{99}Tc at X-231A and B Oil Biodegradation Plots	Environmental data may be available in RCRA closure documentation
9	Determine final disposition for unaccounted for 0.04 MTU of UNH received from Division of International Affairs in FY 1966 – 1967	Low quantity of RU present and locating records may be laborious
10	Quantify the TRU/FP constituents in LEU oxides in storage	Low potential for worker exposure in present storage configuration. High cost associated with sampling and analysis. Results would be of benefit to final disposition